Long-term colonisation and propagule pressure of fish assemblages in a Neotropical floodplain

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Abstract

Biological invasions are a major threat to biodiversity in the Neotropical region. However, few studies have evaluated the mechanisms underlying the long-term establishment of fish propagules in aquatic environments. Here, we associated fish biomass, species richness, and proportion of non-native species (contamination index) to quantify propagule and colonisation pressures, and fish biodiversity (measured by the Kempton's index) in lakes and rivers of the Parana River floodplain. We organised species into native and non-native assemblages sampled by gillnetting and beach seining in spatio-temporal gradients, seasonally, from 2000 to 2017. Native and non-native Kempton's indices were inversely correlated, native extinctions occurred locally with non-native biotic differentiation in lakes, rivers, and ecosystem contamination. A constant propagule pressure resulted in an overwhelming biodiversity of non-natives at the end of the evaluated time series. Biotic resistance to introduction was not evidenced in our deterministic trends. The observed patterns agreed with previous studies highlighting native biotic homogenisation and species extinctions, depending on biological invasions, landscape connectivity, and riverine impoundments. Long-term propagule pressure and non-native fish colonisation were the drivers of biodiversity that led to the predominance of non-native over native assemblages in the Parana River floodplain.

Full Text

This preprint is available for download as a PDF.

Figures

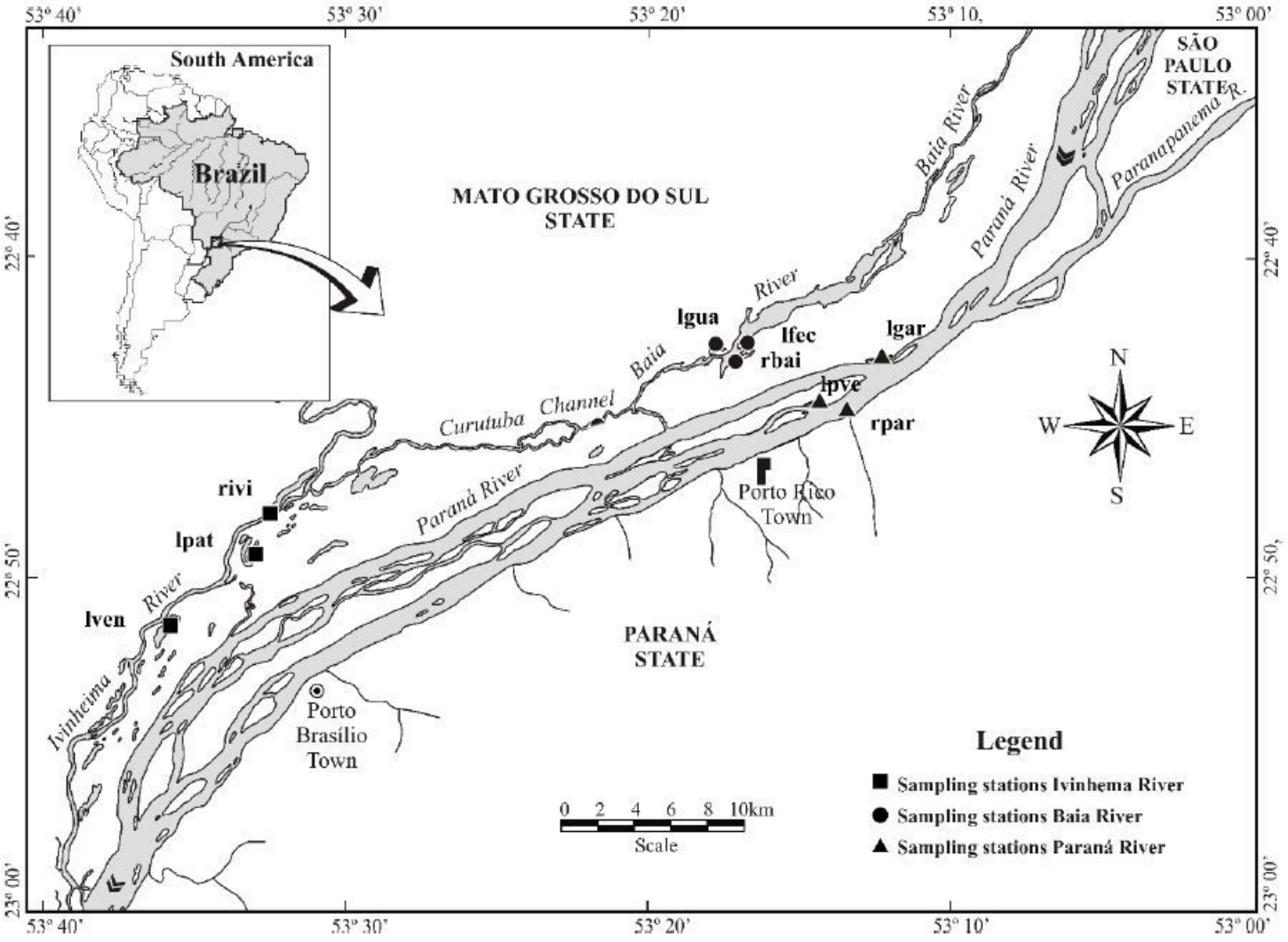

Figure 1

Selected sampling sites of the long-term ecological research program in the Upper Parana River floodplain (2000 to 2017). Standardized monitoring occurred in the following sampling sites: Lakes 6 “lfec” (‘Fechada’) “lgar” (‘Garças’), “lgua” (‘Guarana’), “lpat” (‘Patos’), “lpve” (‘Pau Veio’), “lven" (‘Ventura’) and Rivers “rbai” (‘Baia’), “rivi” (‘Ivinheima’), “rpar” (‘Paraná’).

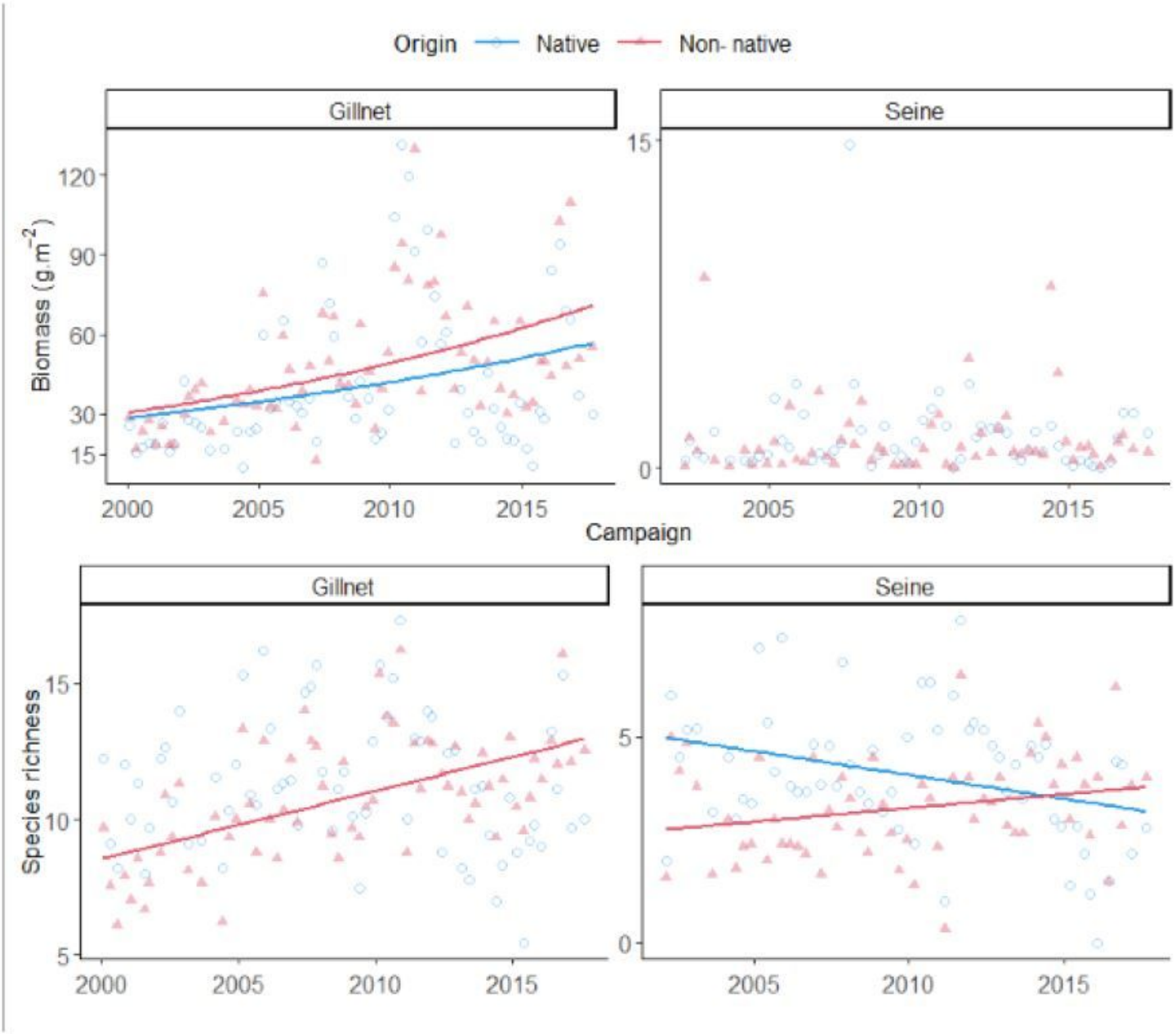

Figure 2

Species richness and biomass of native (blue) and non-native (red) species per seasonal sampling campaigns and methods (Gillnet and Seine) in the Paraná River flood plain from 2000 to 2017. Values were averaged through the six lakes and three rivers in each campaign (details in the Methods section). For biomass, lines represent General Linear Models (GLM, “quasipoisson” distributed with log- link function) and for species richness linear models, both with $P < 0.05$ (see Table 1).

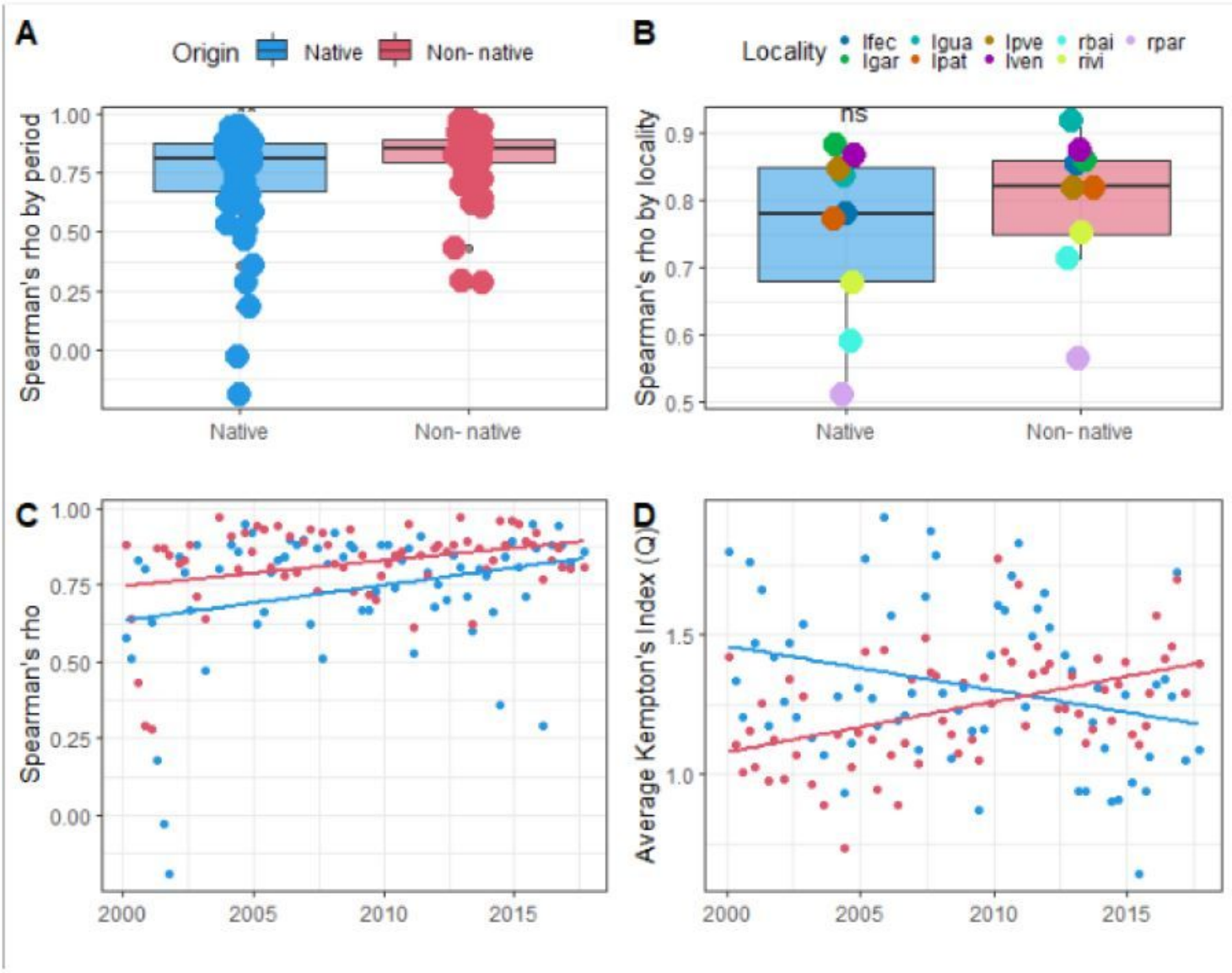

Figure 3

Spearman's correlation coefficient (rho) and average Kempton's Index (Q) between biomass (g.m-2, gillnetting and beach seining in lakes, see Methods section for further details) and specie richness of native and non-native fish species at six lakes and three riverine channels of the Paraná River floodplain sampled seasonally from 2000 to 2017. Frames A and B represent the comparison of rho by sampling periods and localities; C and D are the long-term rho and Q trends with ($P < 0.05$). Differences without tails (**) and Non-significative (ns) comparisons are also identified in A and B. Localities are represented in B with "l" standing for lakes and "r" for rivers (lfec, lgar, lgua, lpat, lpve, lve, rbai, rivi, and rpar). Lakes were "Garças", "Guarana", "Fechada", "Patos", "Pau Veio", and "Ventura"; and the rivers are "Baia", "Ivinheima", and "Paraná".

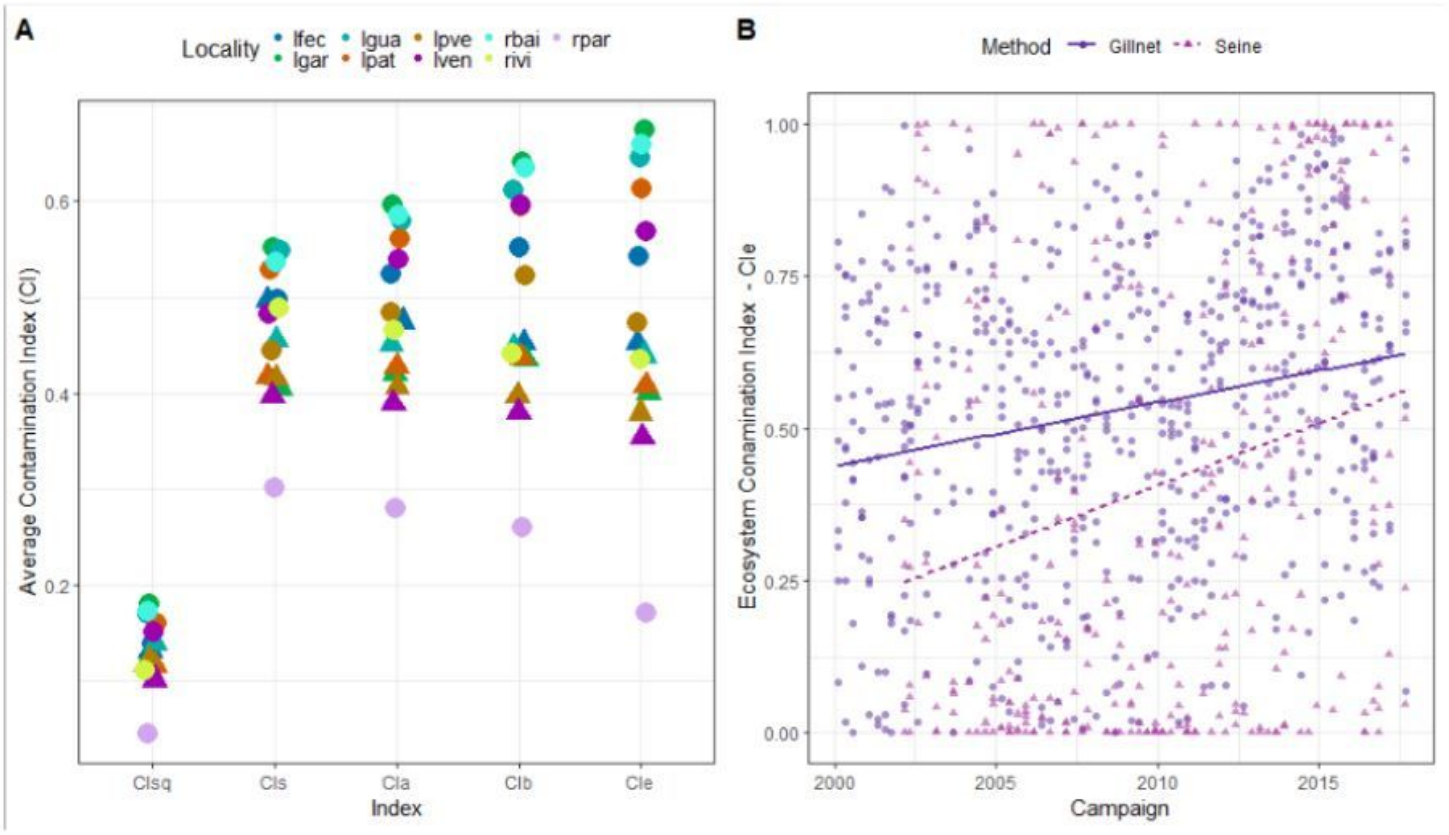

Figure 4

A – Average Contamination Indexes (CI, 2000 to 2017) of fish assemblages in lakes and rivers of the Parana River floodplain. The index accounted for the proportion of non-native species in the assemblages based on fish species richness (CIs), biomass (CIb), as well as richness and biomass (CIe), in additive (CIa) and multiplicative ($CIsq$) forms (further details in the methods section). B – Temporal variation of CIe in each sample. Sampled environments are represented with “l” standing for lakes and “r” for riverine channels (‘lfec’, ‘lgar’, ‘lgua’, ‘lpat’, ‘lpve’, ‘lve’, ‘rbai’, ‘rivi’, and ‘rpar’). Lakes were “Garças”, “Guarana”, “Fechada”, “Patos”, “Pau Veio”, and “Ventura”; and the rivers are “Baia”, “Ivinheima”, and “Paraná”.

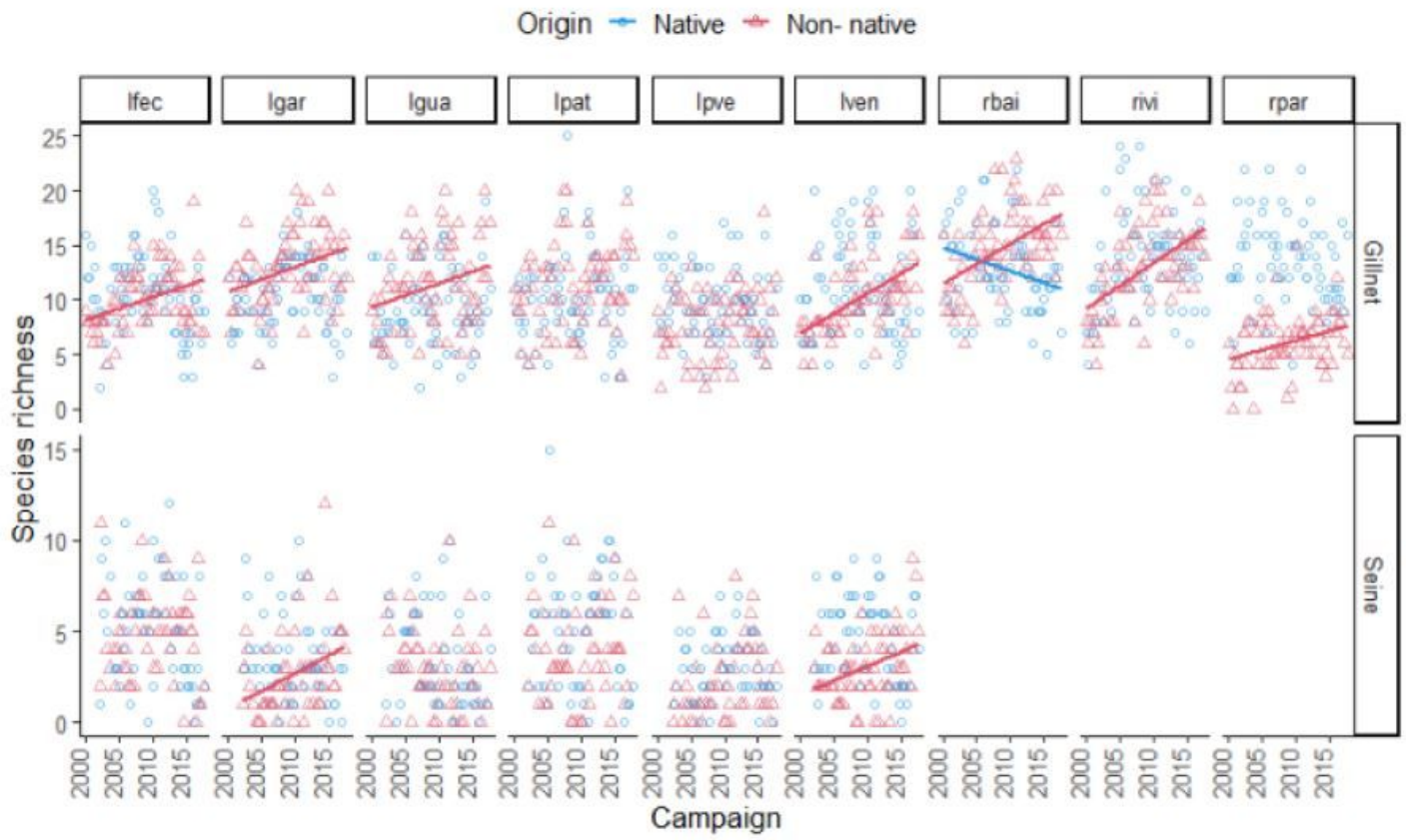

Figure 5

Native (blue circles) and non-native (red triangles) fish assemblage`s species richness in gillnets and seines, from 2000 to 2017, in the Paraná River floodplain. The strip labels represent sampled environments, with “l” standing for lakes and “r” for riverine channels (‘lfec’, ‘lgar’, ‘lgua’, ‘lpat’, ‘lpve’, ‘lve’, ‘rbai’, ‘rivi’, and ‘rpar’). Lakes are “Garças”, “Guarana”, “Fechada”, “Patos”, “Pau Veio”, and “Ventura”; and the rivers are “Baia”, “Ivinheima”, and “Paraná”.